INHALER FOR POWDERY, IN PARTICULAR MEDICAL SUBSTANCES

The invention relates to an inhaler for powdery, in particular medical substances, with a suction air channel leading to a mouthpiece, also a storage chamber for the substance and a linearly moving dosing chamber for apportioning a specific amount of substance from the storage chamber into the region of a transfer point to the suction air stream.

An inhaler of this type is known from DE-A 40 27 391. The amount of substance to be discharged is transferred in a downwardly tapering storage chamber to the dosing chamber, which is capable of moving out. The delivery means is a linearly movable slide comprising said dosing chamber. Placed into the channel of the mouthpiece, a rearward space of the dosing chamber docks onto a volume of air stored in a piston/cylinder unit. When the inhalation takes place in the sense of a suction air stream, the volume of air is abruptly set free and released. The suction stroke, mechanically flow-assisted in this way, clears the dosing chamber in an emptying manner. The expulsion of compressed air triggered by the reduced pressure requires considerable structural complexity; for most patients, it also takes some time and effort to get used to the suddenly occurring surge of air.

An object of the invention is to form an inhaler of the generic type in a structurally simple way, such that there is no longer any need to provide an external air stream but nevertheless a complete discharge of a reproducible portion is obtained.

This object is achieved first and foremost in the case

of an inhaler with the features of Claim 1, it being provided that a component of the suction air stream lying in the direction in which the dosing chamber extends empties the dosing chamber.

As a result of such a configuration, a structurally simple, functionally reliable inhaler is achieved. The inhalation produces a reduced pressure for discharge that is adequate for the dosing chamber to be emptied satisfactorily. The region where the dose is administered lies close to the flow component, in a manner which is extremely effective for the discharge. The linearly moving dosing chamber operates with a drawing effect and, on reaching the transfer point, is so detached from the storage region of the powdery substance that it is no longer possible for any substance to fall back. The prior art attempts to prevent this possible source of unequally apportioned amounts by the use of a screen with respect to the rearward space, that is with respect to the incoming external air stream.

The subject matters of the further claims are explained below with reference to the subject matter of Claim 1, but may also be of importance in their independent formulation. For instance, it is further proposed that the dosing chamber is configured as a transverse bore of a spindle which can be displaced in dependence on a closure cap. In this way, the ready-to-discharge position is as it were automatically brought about, simply by the customary handling of closing and opening taking place. The preferably continuous transverse bore can be cleared out from two sides. A particularly effective measure is obtained by a conical transverse bore. The apportioned amount of substance is transferred even more quickly via the component of the suction air stream from the widening end. To achieve conducting of the air of the component in the direction in which the dosing chamber extends, it is of

significance that an air passage adjoining the suction air stream is associated with the dosing chamber. This produces as it were a localized zone of reduced pressure. It is advantageous for an air passage to be respectively provided upstream of each of the two openings of the dosing chamber. In the case of the conical transverse bore, it is suitable also to provide that associated with the larger clear diameter end of the dosing chamber is an air passage of a smaller diameter than it and associated with the smaller clear diameter end is an air passage of a larger diameter than it. As a result of greater reduced pressure, substance is therefore cleared predominantly from the widening side, that is specifically in the direction in which there is no frictional hindrance as a result of the correspondingly widening walls of the dosing chamber. The invention then proposes that the air passages are formed on a cup-shaped rotary part guiding the spindle and are in flow communication with air inlets in the lateral wall of a mouthpiece. The corresponding air inlets are disposed on the lateral wall of the inhaler in such a way that they cannot be kept closed either by the user's lips or by the gripping hand holding the stick-shaped body of the inhaler. The risk of them being kept closed is minimized moreover by a number of air inlets that are spaced apart from one another being formed. For the purpose of good distribution of the powdery substance in the suction air stream, it is also provided that the air passages are disposed axially offset in relation to the air inlets lying closer to the mouthpiece. This produces an initially contra-acting flow path. Furthermore, it proves to be advantageous for the rotary part to form with its cup base the top of the storage chamber, the center of which has a guiding opening for the spindle acting as a plunger slide. In this way, the cup base is given a dual function: indirect or direct cover and guiding hole for the spindle. Another advantageous feature is for the

spindle, which is pointed at the end in the plunging direction in the manner of a screwdriver blade, to be rotationally connected to the rotary part by means of radial fins. On the one hand, the knife-like blade achieved in this way not only brings about an effective rotationally loosening action in the central region but at the same time also helps the spindle to plunge into the mass of powder, and on the other hand it provides welcome support for the spindle with respect to the rotary part, and what is more makes it possible for the alignment of the air passages with the dosing chamber to be retained. The necessary relative linear movement of the spindle and the rotary part in relation to each other is achieved by simple means, in that the cup wall of the cup-shaped rotary part has axial guiding slots in which the fins are guided. This solution is further characterized by an extension limiting stop of the spindle that is provided by the mouthpiece, defining the ready-to-empty position of the dosing chamber, which with its base wall portion provides the transfer point. The closure-cap dependent mounting of the spindle is further characterized by a docking point between the spindle and the closure cap that lies on the mouthpiece side and disengages if overloaded. When the inhaler is closed again, renewed docking between the spindle and the closure cap is conversely obtained. A configuration that is even of independent significance is then embodied by the fact that the rotary part has a rotor with which a stator is associated, with a scooping effect acting so as to carry substance into the dosing chamber when the rotary part is reversed in its rotation. By this means, the replenishment and density of the amount of powder in the dosing chamber can be kept consistent. In addition to this there is a loosening effect in the surrounding area, which rules out the chance of parts of the powder becoming clogged. Reversed rotation means unscrewing of the closure cap and the accompanying charging action of the, or on the, dosing chamber. To be specific, the

scoop assembly is formed by web-carried rotor blades extending from an annular disk of the base of the rotary part. Said blades have a lancet- or sickle-shaped outline. Two rotor blades lying diametrically opposite each other are realized. As far as the actual structure is concerned, it is also provided that the rotor blades extend substantially on a quarter sector, with a flank directed radially toward the center of the spindle and a blade flank lying approximately at right angles thereto in tangential alignment with the spindle in such a way as to leave a gap. This rules out points of excessive compression. The medical substance adhering for example to a carrier is not rubbed off from it. It is then provided that the flanks lie in a common diametral line. The further structural features are also conducive to the scooping action but do not adversely effect the medicament, in that the rotor engages under the stator in such a way that the stator is formed as a projection protruding radially inward from the inside wall of the storage chamber and extending freely into a rotational path of the rotor. The stator has a trapezoidal outline and is rooted with its base in the inside wall of the storage chamber. The rotational path is axially limited by the underside of the annular disk of the rotary part and the inner side of the rotor blades facing it. Furthermore, a configuration that is advantageous in terms of the association between parts consists in that the stator lies in outline beneath the quarter sector, leaving an interspace between two rotor blades. This produces an adequately large mounting opening. It is advantageous both in terms of sealing and in terms of guidance if the guiding opening within the rotary part is lined by a sealing bush enclosing the cylindrical portion of the spindle. It may comprise rubber or rubber-like material. Powdery substance deposited on the stem of the spindle is wiped off by the sealing bush. There is no falsification of the dose ready to be discharged. A likewise sealing-related measure of the dispenser

mechanism is obtained by a sealing ring inserted with preloading between the inside wall of the storage chamber and the rotary part. Here, too, rubber or rubber-like material may be used. It is then provided that the sealing ring is snap-fitted in annular grooves of both parts, the annular groove located on the rotary part taking the form of a V-shaped notched groove and the annular groove of the storage chamber, lying at the same height as said notched groove, being of a semicircular form. The said notched groove is involved in the rotational guidance of the rotary part. Finally, it is proposed that the closure cap is formed as a screw cap and interacts with the mouthpiece via co-rotating means. The latter are similar to a claw coupling and disengage when there is a separation of the threads.

The subject matter of the invention is explained in more detail below on the basis of an exemplary embodiment illustrated in the drawing, in which:

Figure 1 shows the inhaler according to the invention in a vertical section, enlarged, in the basic position with the cap closed,

Figure 2 shows the plan view of this,

Figure 3 shows the inhaler in side view,

Figure 4 shows the inhaler in section, as in Figure 1, but with the closure cap removed and therefore embodying the ready-to-remove position,

Figure 5 shows an enlargement taken from Figure 1 with the spindle in an intermediate position, the dosing chamber extending at the height of the stator,

Figure 6 shows the section along the line VI-VI in Figure 5,

Figure 7 shows a detailed representation of the rotary part with the rotor and the stator in a perspective view from below, showing the knife-like shape of the lower end of the spindle, and

Figure 8 shows an exploded drawing of the parts forming the inhaler, to be precise in vertical section with respect all the parts, in partial section with regard to the spindle.

The inhaler 1 represented in the drawing is realized as a conveniently portable pocket device in the form of a short stick. A stepped, cylindrical housing 2 determines its shape.

The cylindrical housing 2, which is like a small tube, passes at the top end of the inhaler 1 into an attached mouthpiece 3. This is flattened appropriately for a mouth and can be protectively engaged over by means of a cup-shaped closure cap 4.

The closure cap 4 is realized as a screw cap. An internal thread 5 associated with it engages in a corresponding external thread 6 on the lateral wall of the housing 2. In the region where the mouthpiece 3 is attached, a clip 7 is integrally formed on the closure cap 4.

At the bottom end, the end edge of the cup-shaped closure cap 4 butts against an annular shoulder 8 with a stop-limiting and sealing effect, achieved on account of the aforementioned step of the cylindrical housing 2.

Using the axial screw stroke of the engagement of the threads 5/6, the closure cap 4 acts at the same time as an actuating handle 9 for delivering a powdery substance 10 in reproducible portions 10', which substance is accommodated in a storage chamber 11 of the housing 2 in an optionally refillable manner. The dosing device, respectively transporting the portion 10' to a transfer point Ü lying outside the storage chamber 11, is designated as a whole by D.

With respect to the material that can be dosed, it is a medical, powdery substance 10, for example of the nature that basic substances (lactose) capable of being transported by suction stream act as a vehicle for carrying the micronized fine particles of medicament sticking to their surface.

Provided downstream of the dosing device D is a so-called dispersing region, in which the user produces a suction air stream S which completely carries away the exactly apportioned amount 10' of the substance 10 at the transfer point Ü. The suction air channel leading to the mouthpiece 3 has the reference numeral 12.

The lower termination of the storage chamber 11 is formed by a cup-shaped pressure-exerting base 13. This is under spring loading in the direction of the mouthpiece 3. The corresponding compression spring has the reference numeral 14. It is supported by the bottom end winding on a base cap 15 closing the housing 2 there. Said base cap is in latching engagement with the portion of the housing 2 of larger cross-section there. The corresponding latching collar 16 engages in a matching annular groove of the housing 2.

The top end winding of the biased compression spring 14 loads an inner shoulder 17 of a hollow piston 18 of the piston-shaped device 13/18.

The stepped cup-shaped pressure-exerting base 13 is connected in a latching manner to the inner shoulder 17.

The cup edge of the pressure-exerting base 13 provides an annular lip 19, which on account of its rubber-elastic material wipes off the wall of the storage chamber 21 without any substance being lost.

Then a central standing spigot 20 extends from the base cap 15. Said standing spigot is hollow and, together with the hollow piston 18, forms a spring chamber 21 for the compression spring 14.

At the mouthpiece end, the storage chamber 11 terminates with a cup-shaped rotary part 22. This forms by its cup base the top 23 of the storage chamber 11 engaging over the housing 2.

A guiding opening 24 is left at the center of the top 23. This indirectly or directly formed guiding opening 24 receives a spindle 25, as the key component of the dosing device D. As a result of being appropriately configured, said spindle acts as a linearly moving dosing chamber 26 for the portion 10' to be lifted out, representing a plunger slide. It moves in the longitudinal center axis x-x of the substantially rotationally symmetrically configured inhaler 1.

At its end remote from the mouthpiece 3, the spindle 25 forms a point similar to a screwdriver blade. On account of the co-rotation of the spindle 25, this has a loosening effect on the central region with respect to the mass of powdery substance 10. The blade 27, virtually resembling a pointed roof, has two mirror-symmetrical oblique flanks and, at the base, adjoins the cylindrical stem of the spindle 25. The oblique flanks enclose an angle of about 60°. The cylindrical base cross-section of the spindle 25 is retained in the

region of the blade 27 (see Figure 7). The stroke of the linearly moving dosing chamber 26 makes allowance in both end positions of the spindle 25 for the cross-section of the guiding opening 24 to be kept closed with a doctor-blade or wiping-off effect, filling the dosing chamber, over the length of said opening 24.

The end of the closure 4 toward the mouthpiece forms a docking point 28 between the spindle 25 and the closure cap 4. The latching means on the closure cap is in this case a ring of hooks capable of resilient deflection. Inwardly directed lugs 29 of the resilient tongues of the ring of hooks engage in a narrow waist-like annular groove 30 of the stem 25. In the outward direction, the annular groove 30 continues into a latching head 31. This can be overcome in both directions by the lugs 29. The accumulation of material forming the latching head is approximately lenticular.

The lugs 29, or their resilient tongues, are realized on a small tube 32 which protrudes into the mouthpiece opening 3' and extends from the inner side of the top of the closure 4. It is rooted therein.

The stem 25 is rotationally connected to the rotary part 22 by means of radial fins 33 formed in the manner of spokes. The fins 33 engage with their free end portions, crossing the suction air channel 12, in axial guiding slots 34 - three are already sufficient - of the rotary part 22. The guiding slots 34, distributed at equal angles, are located on the inside of the cup wall 35 of the cup-shaped rotary part 22. The axial guiding slots 34 are, moreover, of such a length that the powder-drawing plunging stroke of the stem 25 out of a filling plane in the storage chamber 11 to the described transfer point Ü above the top 23 is ensured.

The defined ready-to-empty position of the dosing chamber 26 is obtained by an extension limiting stop of the spindle 25 that is provided by the mouthpiece 3. That is the extreme end of a turned-back wall of the mouthpiece 3, which in this way keeps the outlet of the guiding slots 34 closed.

The mouthpiece 3 acts via a lateral wall 37 in an anchoring manner on the neck of the housing 2. There, a latching point 38 is formed between the two parts 2, 3. It may be an irreversible latching point 38. Moreover, as can be gathered, the top 23 of the rotary part 22 is engaged over in a supported manner by an annular shoulder 39.

The dosing chamber 26 is realized as a transverse bore running substantially perpendicularly in relation to the longitudinal center axis x-x. Transferred into the ready-to-empty position, the dosing chamber 26 is in the effective region of the central suction air stream S. An air passage 40 adjoining the suction air channel 12 is associated with the dosing chamber 26. Said air passage is formed in the cup wall 35 of the rotary part 22. It comprises radial bores. They extend in the vicinity of the base of the cup-shaped rotary part 22, that is at the height of, or just above, the upper side of the top 23.

It can be gathered that such an air passage 40 is provided upstream and at a radial spacing from both open ends of the dosing chamber 26. One precaution in this connection is that associated with the larger clear diameter end of the dosing chamber 26 formed by a conical transverse bore is an air passage 40 of a smaller diameter than it and associated with the smaller clear diameter end of the dosing chamber 26 is an air passage 40 of a larger diameter than it. This produces a greater reduced pressure with a predominant discharging effect with respect to the administered

portion 10' downstream of the air passage 40 of smaller diameter. Nevertheless, the discharge, i.e. emptying of the dosing chamber 26, takes place from both ends.

The passages 40 formed on the cup-shaped rotary part 22, guiding the stem 25 in a sealed manner, are also in flow communication via a rearward annular space 41 with air inlets 42 which are at a radial distance. These air inlets 42 are also configured as bores and provide the connection to the atmosphere. Said annular space 41 is located between the outer side of the cup wall 35 of the cup-shaped rotary part 22 and the inner side of the lateral wall 37 of the mouthpiece 3.

It can be gathered that the air passages 40 are disposed axially offset in relation to the air inlets 42. The air inlets 42 lie closer to the mouthpiece 3. The described spatial distancing leads to an initially contra-acting inflow of sucked-in air following on from the main suction air stream S. This and the fact that a component of the suction air stream S lying in the direction in which the dosing chamber 26 extends is built up has the effect that the dosing chamber 26 is completely emptied. The user inhales a precise dose each time. The transfer point Ü is provided here by the base portion of the dosing chamber 26.

Conducive to the corresponding emptying is the special way developed here of keeping the powder substance 10 ready in the drawing region: this is so because conditions are created here to ensure the aimed-for isostructural or homogeneous "packing" of the dosing chamber 26, fed from a surrounding area where the substance has been loosened. The rotary part 22 is used in particular for this purpose, by way of a development. It has a rotor R acting in the upper region of the storage chamber 11. A stator St is associated with said rotor. Using the rotation of the rotary part 22, not only is a loosening effect obtained

but at the same time also a scooping effect acting so as to carry powder into the dosing chamber 26 when the rotary part 22 is reversed in its rotation, i.e. when the closure cap 4 is unscrewed, using the same as an actuating handle 9. The corresponding entrainment is also obtained with respect to the spindle 25, which is rotationally secured radially by means of the fins 33, so that there is no displacement of the axis of the dosing chamber 26 in relation to the air passages 40. Even the lateral wall 37 could be included in the rotational fixing by connecting means with positive engagement. Generally, even co-rotation with frictional engagement is sufficient, for example by means of the annular collar 43 keeping the annular space 41 closed toward the mouthpiece end. Said annular collar extends from the lateral wall of the cup wall 35 and lies with its outer edge against the inner side of the lateral wall 37 of the mouthpiece 3.

As Figures 1 and 4 reveal, the co-rotation between the mouthpiece 3 and the closure cap 4, lifting off by an unscrewing action, takes place by a claw coupling 44 between the two. This comprises a longitudinal toothing 45 on the lateral wall 37 of the mouthpiece 3, which longitudinal toothing engages in corresponding tooth gaps 46 on the inner side of the closure cap 43.

The scoop is formed by two rotor blades 47. These have a basically sickle-shaped outline. The two rotor blades 47 are located diametrically opposite with respect to the longitudinal center axis x-x of the inhaler 1. They are mounted on axially running webs 48 spaced at a distance from the center. The webs are rooted in the underside of an arm or an annular disk 49 of the rotary part 22 providing the rotor R.

The freely extending rotor blades 47 protruding from the base or the top 23 of the rotary part 22 on the storage chamber side are positioned diametrically

opposite in such a way that they are sufficiently spaced apart in the circumferential direction. Geometrically, they substantially take up a quarter sector of the circular cross-section of the storage chamber 11. Reference should be made to Figure 6. The two rotor blades 47 each have a flank 50 aligned radially with the center of the spindle 25 and each have a scoop flank 51 lying at right angles thereto. It runs at a distance from the lateral wall of the spindle 25 in such a way as to leave a gap. The gap has the symbol 52. In this way, an abrasive effect is avoided. It can be gathered that the flanks 50 are diametral. The common diametral line of the flanks 50 is designated in Figure 6 by y-y. The spatially parallel scoop flanks 51 extend perpendicularly in relation to the diametral line y-y and spatially parallel to the axis z-z of the transverse bore of the dosing chamber 26, which in turn coincides with the axis of the bore of the air passages 40.

The annular disk 49 or two arms in which the rotor blades 47 are rooted continues via an annular wall 53 into the top 23 of the rotary part 22.

Figure 5 illustrates particularly clearly that the rotor R engages underneath the stator St in such a way that the stator St is formed as a projection protruding radially inward from the inside wall of the storage chamber 11 and extending freely into a rotational path 54 of the rotor R. It can be gathered that the rotational path 54 is axially limited by the underside of the annular disk 49 of the rotary part 22 and the inner side of the rotor blades 47 facing it. The axial distance forming the rotational path is significantly greater than the thickness of the stator St, that is the projection, measured in this direction. Therefore, mechanical loads with respect to the frictionally sensitive powdery substance 10 to be discharged do not occur here either.

The stator St has a trapezoidal outline. Its arcuate base is rooted in the inside wall of the storage chamber 11. The base is dimensioned such that the stator St narrowing radially inward in its surface area lies in outline beneath the quarter sector, leaving an interspace 55 between two rotor blades 47. As Figure 6 reveals, this at the same time provides an adequate mounting opening for the stator to engage in the rotational path 54.

The radial projection of the stator St in the inward direction is of such a radial length that the plateau of the trapezoid ends before the outer side of the web 48, likewise forming a gap.

The scooping effect is clear from Figure 6 if the arrows are observed. Arrow a indicates the direction of reversed rotation of the rotary part 22. The scoop flanks 51 therefore act as a face pushing the powder lying in front of it. Arrow b shows the approaching scooping-in direction with respect to the end of the dosing chamber 26 having the larger clear diameter. Arrow c indicates the corresponding action at the other rotor blade 47, that is here also with respect to the scooping action of the scoop flank 51. The stator St then stands as it were as a fixed chicane in the way of the rotational path 54. The powdery substance 10 is displaced with a rapidly chamber-filling effect by the scoop flank 51 lying closer to the directing-in flank of the trapezoid, so that, as already stated, consistent filling conditions always occur. The dosing chamber 26 moves in an ascending manner through the zone of the dosing device D in a number of rotations until it has reached with its transfer point Ü the upper side of the top 23 of the cup-shaped rotary part 22.

There is also no entrainment of powder material that may be adhering to the lateral surface of the spindle, as a result of the guiding opening 24 with a wiping-off effect. Said opening is not formed directly by the rotary part 22, but by a sealing bush 56 lining this passage. Said sealing bush consists of rubber-elastic material and is held by being clipped into the top 23 by latching means 57. In terms of its plane, it reaches at the top up to the height of the upper side of the annular disk 49.

However, there is also no radially outer escape hole for powder losses, since there is likewise a sealing element between the rotary part 22 and the housing 2 forming the storage chamber 11. This is achieved by a sealing ring 58 of rubber-elastic material inserted between the inside wall of the storage chamber 11 and the rotary part 22. Said sealing ring 58 is inserted under preloading. The sealing ring 58 is snap-fitted in annular grooves of both parts 2, 22. The annular groove located on the annular part 22 has the reference numeral 59. It is realized as a V-shaped notched groove. The opening angle of the annular groove 59 lying in the region of the annular wall 53 is about 90°. The groove contour has a centering and rotationally guiding effect. The other annular groove 60, lying at the same height, is located on the inner side of the housing 2, to be precise in the upper inlet region of the storage chamber 11. Here there is a semicircular shape with respect to the cross-section of the peripheral annular groove 60. Mounting is made easier by a rotationally symmetrical run-up slope 61 provided in front of the annular groove 60.

The spindle 25, formed as a lifting spindle, can be varied with respect to the volume of its dosing chamber 26, i.e. the key component of the dosing device D merely has to be exchanged to achieve a different, precisely reproducible dosing of portions 10'.

The pressure-exerting base 13, acting in the manner of a piston, is not impaired in its ability to move with respect to the cylinder space, provided by the central portion of the housing 2, since there the housing has an air-equalizing opening 62 lying to the rear of the annular lip 19.

The cup-shaped pressure-exerting base 13 has a central indentation, directed away from the storage chamber 11. It is of such a depth on the inside that the end portion of the spindle 25 projecting axially downward beyond the rotor blades 47 in the basic position is accommodated in it.

All features disclosed are (in themselves) pertinent to the invention. The disclosure content of the associated/attached priority documents (copy of the prior patent application) is also hereby incorporated in full in the disclosure of the application, including for the purpose of incorporating features of these documents in claims of the present application.